Research Article

JRAD Journal of Research and Advancement in Dentistry

J Res Adv Dent 2019;9:3s:384-394.

Endosseous Implants and Bone Augmentation in the Posterior Edentulous Maxilla by Various Maxillary Sinus Lift Procedures

Shwetang Goswami[1*] Pramod Kumar G[2] Mohsin Ali[3] Vikram[4] AP Mohan[5] Sudhakar Meher[6] KA Jeevan Kumar[7]

[1]Reader, Department of Oral and Maxillofacial Surgery, Sri Balaji Dental College & Hospital, Hyderabad, Telangana, India.
[2]Professor and Head, Department of Oral and Maxillofacial Surgery, Sri Balaji Dental College & Hospital, Hyderabad, Telangana, India.
[3]Reader, Department of Oral and Maxillofacial Surgery, Sri Balaji Dental College & Hospital, Hyderabad, Telangana, India.
[4]Professor and Head, Department of Prosthodontics, Sri Balaji Dental College & Hospital, Hyderabad, Telangana, India.
[5]Professor, Department of Oral and Maxillofacial Surgery, Kamineni Institute of Dental Sciences, Telangana, India.
[6]Reader, Department of Oral and Maxillofacial Surgery, Sri Balaji Dental College & Hospital, Hyderabad, Telangana, India.
[7]Professor, Department of Oral and Maxillofacial Surgery, Kamineni Institute of Dental Sciences, Telangana, India.

ABSTRACT

Background: A study was done to evaluate the success of implants placed in the deficient posterior maxillary ridges following a vertical augmentation procedure either a direct or indirect sinus lift with immediate implant placement.

Materials and Methods: A total of 12 patients were chosen for the study. Patients with a residual alveolar ridge of 8 mm and less in posterior edentulous maxilla were chosen. The implant success was evaluated both clinically and radiographically over 6 months, 1 year and 3 year follow up period.

Results: Both direct and indirect sinus lifts are predictable procedures, even though in our study we used both, we more often chose a direct sinus lift procedure and it gave more predictable results owing to the better quality and quantity of grafted bone and its good turnover over 1 and 3 years,

Conclusion: both the techniques are equally predictable and with the recent advances that have taken place in the field of equipment, surgical expertise, and know how, better graft material and membranes, sinus lift is a predictable procedure for rehabilitation in the posterior maxilla.

Keywords: direct sinus lift, indirect sinus lift, allograft, xeno graft, endosseous implants, maxillary sinus.

INTRODUCTION

When teeth are extracted in the posterior maxilla, bone in that area is lost due pneumatisation of the maxillary sinus[1].The posterior maxilla might have both a vertical and a horizontal bone defect. The most predictable treatment option for treating the vertical bone defects is sinus grafting procedures. It may be done as a direct or an indirect sinus lift procedure, other than the hydraulic lift which has been recently documented.

Residual bone height measuring between 6-8 mm can be treated by an indirect sinus lift whereas a defect between 6 to 4 mm can be treated by a direct sinus lift with immediate placement of implants. A defect that has bone lower than 4 mm in height can been treated as a two staged procedure which requires a primary sinus grafting procedure which is done 6 months prior to the placement of the implants.

Received: Apr. 12, 2019**: Accepted**: May. 26, 2019
***Correspondence Dr. Shwetang Goswami.**
Department of Oral and Maxillofacial Surgery, Sri Balaji Dental College & Hospital, Hyderabad, Telangana, India.
Email: shwetang14@gmail.com

pISSN 2278-0076
eISSN 2321-9270

Different solutions other than sinus lifts have been proposed to overcome this problem, such as use of short implants, [6-10] tilted implants placed in the anterior maxilla, [11-12] and zygoma implants, [13-14].

In recent years, these concepts have been challenged, with success reported using the one-step approach for posterior maxillary ridges measuring as little as 1mm in height with sinus lift and grafting[15].

Though our main aim of the study is to see the success results of the two sinus lift procedures, while studying any limitations in each technique, we also intend to study the minimal bone height required to place the implants, the efficacy of the human allografts in bone formation and the longevity of these successful implants.

MATERIALS AND METHODS

A total of 12 patients with resorbed posterior maxillary edentulous ridges were selected for the study of placement of implants using various sinus lift procedures. The patients were between the age group of 30-72. Out of the 12 patients 6 were male patients and 6 were female patients.

The patients were divided into two categories one with bone height of less than 6mm and one with bone height between 6-8mm. all the patients were evaluated preoperatively, intra-operatively and post operatively for various parameters clinically and radiographically at different time intervals.

The maxillary alveolar bone was assessed in all patients using a CT scan. A 0.6mm section Dentascan was taken for all the patients and the bone height in the desired regions was measured (FIG 1). In our study 7 patients had a bone height of less than 6mm and were treated by a direct sinus lift procedure and 5 patients had a bone height between 6-8 mm and were treated by an indirect sinus lift procedure (TABLE I**)**.

There were 7 cases in which bilateral sinus lift procedures were done simultaneously and there were 5 cases in which a unilateral sinus lift procedure was done either by a direct or an indirect sinus lift procedure based on the pre-operative bone height.

Dental and medical examinations of all the patients were done prior to the procedure to make sure the patients were fit for the surgery based upon the exclusion criteria which included: uncontrolled systemic diseases, ongoing chemotherapy, or radiation therapy, history of maxillary sinus disease, Immuno-compromised patients, or immunosuppressed patients, untreated periodontitis, lack of opposing dentition/ prosthesis in the area intended for the implant placement and acute or chronic infection or inflammation in the area intended for implant placement were excluded.

The inclusion criteria for the study were:

1. Minimum of 3 mm and maximum of 8 mm of alveolar bone height in the posterior maxillary region
2. Sinus floor augmentation for atleast one of the implant is indicated,
3. Patients without any systemic diseases,
4. Patients without any pathologies affecting the maxillary sinuses

Two main approaches were considered. The first approach, lateral antrostomy with simultaneous implant placement and second was the osteotomy technique with simultaneous implant placement. Posterio-superior alveolar and Greater palatine nerve blocks combined with infiltrations were given. A horizontal incision was made on the crest or palatal aspect of the edentulous ridge, with extensions beyond the areas of the osteotomy and with consideration of the amount of attached gingiva on the alveolar crest. The incision was carried forward beyond the anterior border of the sinus. A vertical releasing incision was given in the canine fossa. The lateral wall of the maxilla was exposed by reflecting the mucoperiosteal flap superiorly. Elevation of the periosteum adjacent to the implant site was minimized to preserve the blood supply to the alveolar crest. The periosteum was reflected superiorly, just beyond the height of the superior aspect of the anticipated opening into the maxillary sinus.

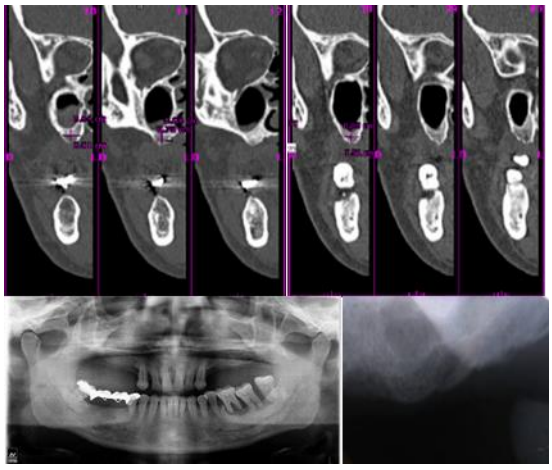

Fig 1: Preoperative CT Scan and OPG And IOPA.

Fig 2: Direct sinus lift.

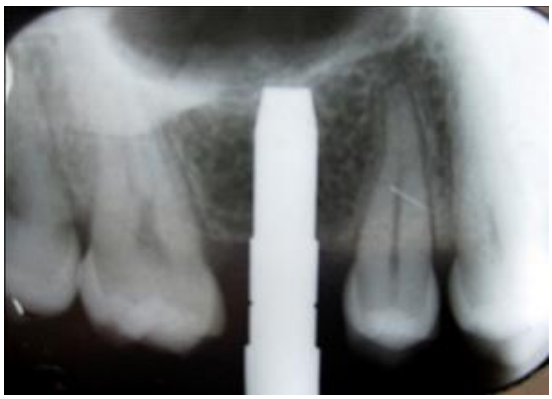

Fig 3: Periapical radiograph to evaluate the depth.

After the lateral maxillary wall was completely exposed, a HP 8 round fissure bur was used at low speed Hand high torque to create an oval shaped osteotomy in the lateral wall of the maxilla (FIG 2). The coronal part of the antrostomy is best made 3 to 4 mm above the sinus floor.

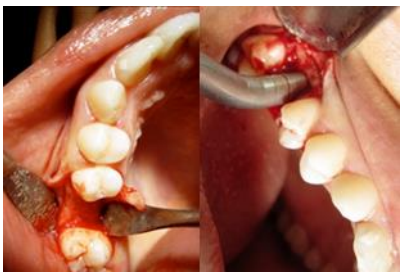

Fig 4: Osteotome technique

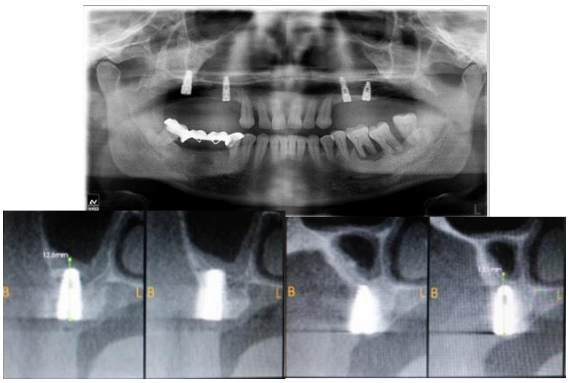

Fig 5: Post-op OPG and CT Scan (Direct Sinus Lift).

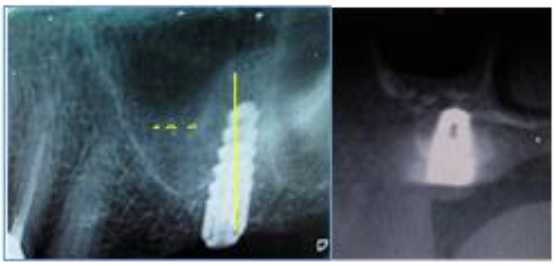

Fig 6: Post-op OPG and CT Scan (Indirect Sinus Lift).

The mesial part of the antrostomy should be as far forward as possible, 3 to 4 mm from the sloping anterior wall, as the anterior recess is usually narrow and is the site of a high incidence of surgical difficulties during membrane elevation. The bone was removed to create a window for better visualization and access. The underlying Schneiderian membrane was exposed. A curette was introduced gently along the margin of the created access window, with the curved portion of the curette placed against the Schneiderian membrane and the sharp

edges placed against the bone and the membrane was elevated. The integrity of the sinus memberane was checked by its movement while the patient is breathing (Valsalva procedure). Any perforation of the membrane will result in the collapse of the membrane. However minor perforations upto 2 mm in size can be repaired/sutured or covered with GTR membrane or Collatape. And superior-inferiorly more than the height of the implant planned.

Indirect sinus lift

In this technique a minimum of 6-8 mm of bone height is required. After local anaesthesia a mid-crestal incision was given, and buccal and palatal full-thickness flaps were reflected. A round bur was used to mark the position of the implant and a pilot drill to define the angle of the implant. The pilot drill ended approximately 1-2mm below the sinus floor calculated from the presurgical X-ray. Preparation of the recipient sites was performed by use of osteotomes of increasing diameter. A hand osteotome was used under a gentle malleting force to cause initial fracture of the sinus floor. The force required for malletting should be not more than 20 MPa.[116] The sinus floor was then elevated using osteotome to displace the Schneiderian membrane apically. This step was performed manually with special attention to avoid perforation of the membrane. We took a periapical radiograph to evaluate the depth to which the osteotome had penetrated FIG 3.

The graft material was inserted in the osteotome site, before making any attempt to raise the floor. When the last osteotome was inserted, the sinus compact bone was infractured using small mallet strikes and the sinus floor was lifted (FIG 4). If excessive malleting is required to perforate the sinus floor, it may be advisable to use the bur to perforate the bone. Coatoam[17] (1997) suggests infracturing the sinus floor directly with a convex-tip osteotome before proceeding with adding graft material.

Once the desired amount of sinus membrane elevation was attained the implant was placed simultaneously in the same appointment. An IOPA was taken post operatively to confirm the sinus floor elevation and the proper alignment of the implant. Later the healing cap was placed and the flap was closed using resorbable 3-0 Vicryl suture material.

Three different implant systems were used in our study which included Uniti™ implant system, Nobel Biocare™ implants and Myriad™ implant system. A total of 37 implants were placed using either a direct or indirect technique in 19 sites.

Allograft and xenograft materials were used in our study to augment the posterior maxillary ridge. The graft material used was human demineralised bone matrix allograft (Tata Memorial Hospital) of size > 1040 µ which was used in 10 patients and Xenograft that was used in 2 patients.

RESULTS

After prosthetic treatment all implant sites were clinically evaluated for their stability at an interval of 6 months for the first one year and then annually till 3 years on the basis of clinical stability. Bone gain was assessed in the CT scans taken at 6 months postoperatively. Implant success or failure was evaluated according to the criteria defined by Albrektsson et al.. Implant survival was based on parameters including, the stability of the implant, bone density around the implant as seen on CT scan taken 6 months postoperatively, absence of painful symptoms, absence of peri-implant radiolucency, and absence of progressive marginal bone loss of >5mm.

Implants were considered to be successful if radiographic evaluation revelaed no more than 1.5 mm of marginal bone loss during the first year of loading and no more than 0.2 mm resorption per year in subsequent years. The assessment of bone resorption was done using standardised digital panaromic radiographs taken by an independent person blinded to the surgical procedure. The same person evaluated all the imaging results. For all patinets, the same radiographic protocol was used, with standardised position of the head, dose, intensity, and time of exposure. A blinded surgeon and prosthodontist, both of whom were not involved in surgical and prosthodontic

Table 1: Residual bone height.

Residual Bone Height	Number Of Implant	Technique Used	Implant Placement
3.0-3.9	1	Direct Sinus Lift	Simultaneous
4.0-4.9	5	Direct Sinus Lift	Simultaneous
5.0-5.9	12	Direct Sinus Lift	Simultaneous
6.0-6.9	15	Direct And Indirect Sinus Lift	Simultaneous
7.0-7.9	4	Indirect Sinus Lift	Simultaneous

Table 2: Length of the implants chosen based on the height of the alveolar bone.

Residual Bone Height	Length Of The Implant Used				No. Of Implants Placed
	8	10	11.5	13	
3.0-3.9	0	1	0	0	1
4.0-4.9	0	5	0	0	5
5.0-5.9	0	11	0	1	12
6.0-6.9	4	6	0	5	15

Table 3: Evaluation of bone gain on CT scan.

Case	Preoperative Bone Height In Mm	Postoperative Bone Height In Mm	Vertical Bone Gain In Mm
1.	Left :5.2 Right :3.9	Left:12.3 Right:11.1	Left:7.1 Right:7.2
2.	Left :4.8 Right :5.3	Left:13.0 Right:12.3	Left:8.2 Right:7..0
3.	Left :5.1 Right :6.4	Left:12.6 Right :13.1	Left:7.5 Right :6.7
4.	Left :-- Right :5.5	Left:---- Right:11.5	Left:---- Right:6
5.	Left :6.3 Right :5.9	Left:13.3 Right: 12.8	Left:7.0 Right: 6.9
6.	Left :5.7 Right :--	Left:11.6 Right :---	Left:5.9 Right :---
7.	Left :4.6 Right :---	Left:11.9 Right:---	Left:7.3 Right:---
8.	Left :6.5 Right :6.9	Left:13.4 Right:13.5	Left:6.9 Right:6.6
9.	Left :--- Right :7.4	Left:--- Right :10.8	Left:--- Right :3.4
10.	Left :6.6 Right :6.9	Left:12.4 Right :12.3	Left:5.8 Right :5.4
11.	Left :7.2 Right :---	Left:10.6 Right :---	Left:3.4 Right :---
12.	Left :7.3 Right :6.4	Left:9.6 Right :10.3	Left:2.3 Right :3.9
MEAN	5.99	12.02	6.02

Table 4: Density of bone around the implant.

CASE	MAXIMUM DENSITY	MINIMUM DENSITY	MEAN DENSITY
1.	721	75	398
2.	564	71	317.5
3.	634	128	381
4.	934	156	545
5.	865	64	464.5
6.	704	231	470.5
7.	735	153	444
8.	789	127	458
9.	941	115	528
10.	694	93	393.5
11.	- 45	122	38.5
12.	864	147	505.5
Mean	412		

Table 5: Clinical stability of the implants.

Case	Clinical	Implant Bone Interface	Mean HU
1.	Firm	<1 Mm	398
2.	Firm	<1 Mm	317.5
3.	Firm	<1 Mm	381
4.	Firm	<1 Mm	545
5.	Firm	<1 Mm	464.5
6.	Firm	<1 Mm	470.5
7.	Firm	<1 Mm	444
8.	Firm	<1 Mm	458
9.	Firm	<1 Mm	528
10.	Firm	<1 Mm	393.5
11.	Mobile	>1 Mm	38.5
12.	Firm	<1 Mm	505.5

Table 6: Clinical evaluation and evaluation of bone formation on opg.

CASE	POST OPERATIVE INFECTION	CONDITION OF BONE FORMATION			
		Macroscopic	Panorama X Ray		Regenerated Bone In The Sinus Area On CT Scans
			3rd Month	6th Month	
1.	_	+	++	++	Thick
2.	_	+	++	++	Thick
3.	_	+	++	++	Thick
4.	_	+	++	++	Thick
5.	_	+	++	++	Thick
6.	_	+	++	++	Thick
7.	_	+	++	++	Thick

8.	_	+	++	++	Thick
9.	_	+	++	++	Thick
10.	_	+	++	++	Thick
11.	_	+	++	++	Thick
12.	_	+	++	++	Thick

Formation Was Seen Visually And On Palpation, The Hardness Was Equal To That Of Native Bone (+).
• No Post-Operative Infection Was Seen In Any Of The Cases (-)
• Cases In Which Bone Opacity Was Clearly Far Lower Than That Of The Native Bone Were Marked (-)
• Cases In Which Bone Opacity Was Close To That Of The Native Bone But Still Lower Were Marked (+)
• Cases In Which Bone Opacity Was Equal Or Nearly Equal To That Of Native Bone Were Marked (++)

Table 7:

	Time Period	Number Of Implants	Failed	Survival Rate
Direct	6 Months	22	1	95.45%
Indirect	6 Months	15	1	93.33%
Cumulative Success Rate	6 Months	37	2	94.59%

procedures, evaluated the remaining clinical parameters of implant survival. The peri-implant tissues were evaluated using sulcus bleeding and plaque index, as well as probing depths from the gingival margin at the buccal, lingula, distal, and mesial surface of the implants.

In addition to this post-op CT scan taken 6 months later has given us a perfect picture on the bone-implant interface. The CT scan offered us the best marginal definition of the osseointigrated implants. The bone density was also measured in terms of Hounsfield Units. The CT density scale is quantitative and meaningful in identifying and differentiating structures and tissues. The findings are somewhat significant. The Hounsfield units were assessed mesially, distally and apically, in our study a mean density of 412 Hounsfield units was seen (TABLE V).

We have evaluated the amount of bone gain both on the OPG's and CT Scans. While the results in the OPG are not predictable more emphasis was given on the CT scans. The bone gain was accurately measured on CT Scans. The method was similar to what we followed on an OPG, except that we didn't have to calculate the magnification error as it is irrelevant on CT Scans. The mean bone gain in direct sinus lift was 6.9 mm and in indirect sinus lift cases was 4.7 mm (TABLE III).

DISCUSSION

The use of osseointegrated implants is currently an efficient, reliable method for short and long term treatment of patients affected by partial or total edentulism. The rate of success and predictability of implant treatment depends on several factors, but is generally rather high. In the past an inadequate volume and a low quality of bone tissue were contraindications to implant treatment.

In particular, due to low bone quality and the tendency for progressive resorption after tooth loss, the posterior maxilla has always been a high risk area for rehabilitation with implant supported fixed prosthesis, atrophic alveolar ridges and/or a highly pneumatised maxillary sinus[1-5], are conditions that imply a limited amount of residual bone, the task becomes even more difficult. One solution is resorting to reduced length implants[6-10], but in this case particular clinical parameters must exist to avoid biomechanical problems due to the poor implant/crown ratio between the length of the implant and that of the restoration.

In such compromised cases, implants require careful planning and may need pre-prosthetic surgery involving bone grafting of the maxillary sinus, which is aimed at correcting bone quantity defects and creating optimal conditions for inserting the implants in the posterior areas of the jawbone.

In 1984, based on clinical and experimental evidence, Branemark showed how the apical end of an osseointegrated implant can be inserted into the maxillary sinus without altering the state of the health of the sinus on the condition that the Schneiderian memberane remains intact. These experiments were meant to show how a bone graft is not always necessary for implant placement in the posterior areas of the atrophic jawbone. However, the failure rate for this procedure reported by Branemark was rather high (upto 70%), in an observation period that ranged from 5 to 10 years of functional loading.

The first documented experiences of bone grafts in the maxillary sinus, together with reconstructions using prosthesis, date back to the late 1960's, attributed to Philip J. Boyne.[16] He had to carry out "secondary alveolar osteoplasty" operations on the alveolar processes of the maxilla. Boyne augmented the maxillary sinus floor with a cortico - cancellous graft harvested from the iliac crest [16].

Later in the 1970's the same surgical procedure for lifting the maxillary sinus for pre prosthetic rehabilitation was carried out, though rarely on patients with highly pneumatised sinuses who needed to undergo implantation procedures using blade implants. The first paper concerning the treatment of patients with endoosseus implants associated with maxillary sinus elevation operations was published in 1980 by Boyne and James.[16] The maxillary sinus was accessed via antrostomy in order to create a bone build up. The latter was then delicately pushed and turned inside the antrum, a manoeuvre that necessitated the partial separation of the Schneiderian membrane from the sinus floor. The bone graft was then inserted below the membrane and the opening was closed. The material used for the graft was generally autogenous one, and the blade implant was inserted in a subsequent operation, some months after the sinus elevation.

Progress in the field of biomaterials and the refinement of techniques and protocols for the rehabilitation of edentulism using osseointegrated implants contributed to increase the success rate and the predictability of implant treatment. There has therefore been an increase in the use of osseointegrated implants in clinical practise and an expansion of research on innovative surgical techniques.

Over the years various techniques have been proposed for maxillary sinus augmentation which differ in the surgical protocol (the method and anatomic site for carrying out the antrostomy); in the autogenous bone harvesting site; in the type of graft material used (autogenous , alloplastic), in the timing of the implant surgery in relation to maxillary sinus floor elevation (simultaneous , i.e., during the same surgical procedure ,or later, during the further surgical session); in the use or non-use of resorbable or non resorbable membranes and in the extent of the elevation of the sinus membrane . This heterogeneity, which is often present in the refinement stage of any innovative surgical procedure, shows how the method for sinus augmentation has not yet been optimised. The ideal method is based on solid principles, but at the same time the type of surgical procedure should be chosen and adapted depending on the patients specific needs and characteristics.

An optimal aesthetic and functional prosthesis can be achieved when the maxillary bone has precise morphologic requisites: the height and thickness of edentulous bone must be at least 5 mm, and there must be a sufficient quantity of keratinized tissue and an adequate depth of the vestibular fornix .[18] However, it is commonly found that when teeth are lost, the alveolar bone is resorbed at varying rates, owing to the lack of mechanical stimulus transmitted by the roots. Resorption first begins on the horizontal level, and then later affects the height of the alveolar bone, which decreases progressively, in some cases reaching as far as the basal bone.

In addition to the physiologic bone resorption of edentulous ridges, mechanical trauma caused by removable prostheses often occurs, and it causes further progressive resorption of the edentulous ridges.[19] Moreover, it is necessary to have adequate shape and volume of the ridges and a normal maxillo-mandibular skeleton relationship on the three planes in order to achieve satisfactory long-term results of fixed implant prostheses.

In our study we have done critical clinical and radiological assessment of all the cases and the patients are classified as per the study of Chiapasco et al[16] in 2003 and were classified according to it.

The bone gain was accurately measured on CT Scans. The method was similar to what we followed on an OPG, except that we didn't have to calculate the magnification error as it is irrelevant on CT Scans. The mean bone gain in direct sinus lift was 6.9 mm and in indirect sinus lift cases was 4.7 mm.

There was one implant site with a bone height between **3.0 – 3.9 mm** and an implant of size 5.3 x 10 mm was placed (case 1).There were five implant sites with a bone height between **4.0 – 4.9 mm** and 3 implants of size 3.7 x 10 (two) (case 2) and 4.3 x 10 (three) (case 7) were placed. There were 12 implant sites with a bone height between **5.0 – 5.9 mm** and implants of size 5.3 x 10 (2) (case 1), 3. 7 x 10 (2) (case 2), 3.7 x 10 and 3.7 x 13 (case 3), 4.3 x 10 (case4), 4.3 x 10 (2) (case 5), 4.3 x 10 (3) (case 6), were used placing a total of 12 implants in such sites (TABLE II).

All these above mentioned cases were treated with a direct sinus lift procedure and immediate implant placement was done in all these cases after ascertaining primary implant stability. In one of the cases (case number 5) the implant was lost 6 months after loading (TABLE VII).

In this case the implant stability was unquestionable at the time of prosthetic rehabilitation, the stability was assessed clinically by its zero moment and radiologically by its close interface between the implant and bone surface which was morphologically proved by 464.5 Hounsfield units on CT scan. Subsequently we have rehabilitated the patient prosthetically but the patient had returned after 6 months complaining of loosening of implant along with its abutment and the prosthetic crown. Eventually the implant came out of its original position. The reason for the failure could not be ascertained by us.

One radiographic success/failure criterion for implant systems is the marginal bone level surrounding the implant. During the first year, marginal bone resorption of a maximum of 1.5 mm has been accepted; during the following years, marginal bone loss of 0.2 mm annually is considered acceptable. Panaromic radiographs or intraoral radiographs are commonly used to assess the bone height, and panaromic radiographs have also been used to get a general overview of the available bone during planning for implant placement.[54]

Based on the findings by various investigations, the reason for failure could be rapid resorption of the bone apical to the implant, for reasons which could neither clinically or radiographically be assessed.

There were 15 implant sites with a bone height between **6.0 – 6.9 mm** and implants of size 3.7 x 13, 4.3 x 13 (case 3) and 5.3 x 10, 4.3 x 10 (case 5) and 4.3 x 13, 5 x 8 and 4.3 x 13 and 3.5 x 13 (case 8), 5.3 x 10 (4) (case 10), 5.7 x 8 (3) (case 12) and a total of 15 implants were placed in these sites.There were two cases (case 3 and case 5) in the study in which even though the height was between 6.0-7.0 mm we had used a direct sinus elevation technique to attain sufficient elevation and augmentation of the sinus which would not have been possible through an osteotome technique.There were 4 implant sites with a bone height between **7.0 – 7.9 mm** and implants of the sizes 5 x 8 (case 9), 5.7 x 8 (1) (case 11) and 5.7 x 8 (2) (case 12) were used placing a total of 8 implants (TABLE II).

All the cases with a bone height between 6.0 to 7.9 mm were treated with an indirect sinus lift procedure (except case no. 3 and case no. 5) and the implant insertion was done in a single stage along with the augmentation procedure.

Amongst these patients a single implant was lost in case number 11 after a period of 6 months. Again the reason for the failure could not be fully ascertained. What we presume is it could be due to excessive force used while malletting and poor bone quality.

Intraoperatively there was no complication and no tear of the Schneiderian membrane was encountered. Common rates from a meta-analysis indicate 18.4% (Kreisler et al. 2007). Two other studies described values of six perforations in 30 operations (20%)[21] and 51 out of 216 cases (23.6%). The highest value in the literature is 36/81 (44%).

Volume of graft material inserted was also different in the two techniques, while approximately 3-3.5 cc of bone graft material was needed for lateral window technique for a two implant procedure; only 0.5 cc to 1 cc of graft material was needed in crestal approach per implant.

This study is more or less similar to a volumetric study of the maxillary sinus conducted by Uchida et al. in 1998 which has found that on average, 5.46 cm^3 of material is needed to develop 15 mm of graft vertically, a volume of 3.5 cm^3 is usually adequate for placing three 13 mm long Implants.[22]

CONCLUSIONS

The present study indicates both the lateral window technique and the crestal approach are versatile procedures for the rehabilitation of the posterior maxillary area. In our study both the techniques have given positive results. In both the techniques simultaneous placement of the implants i.e. one step procedure proved to be sufficient and successful thereby avoiding a second surgery and long await for dentures for the patients.

But there are certain protocols that must be followed for this kind of success, whenever the bone height is less that 4 mm, whenever there is a requirement of the bone height more than 4 mm then lateral window technique is only a choice. A crestal approach is safe and less invasive provided bone height in more than 6 mm and requirement of sinus membrane elevation is not more than 4 mm. this protocol combined with meticulous technique will achieve predictable results

The study showed successful outcome in the one-stage procedure even when the bone height was as low as 3.9 mm. The stability of the implants was proven by various clinical and radiological assessments. With the results and the successful outcome one can safely carry out sinus lift procedure with immediate implant placement along with allograft/xenografts bone substitute materials combined with resorbable bio-membrane even in situations of minimal bone height as low as 3 mm as long as the primary stability is ensured.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

REFERENCES

1. Jihad Abdallah, Augmentation Procedures for the Maxillary Sinus: A Case Report with 10-year Follow-up; International Journal of Oral Implantology and Clinical Research, May-August 2011; 2 (2):105-109.

2. Kent J N, Block M S, Simultaneous maxillary sinus floor bone grafting and placement of hydroxyapatite-coated implants. J Oral Maxillofac Surg 1989; 47: 238-42.

3. Fugazzotto PA. Maxillary sinus grafting with and without simultaneous implant placement: Technical considerations and case reports. Int J Periodont Rest Dent 1994; 14: 544-51.

4. Summers RB. The osteotome technique: Less invasive methods of elevating the sinus floor (Part 3). Compendium 1994; 15: 698-708.

5. Jensen O T, Shulman L B, Block M S, Iacono V J. Report of the Sinus Consensus Conference of 1996. Int J Oral Maxillofac Implants 1998; 13(Suppl):11-45.

6. Matteo Chiapasco and Marco Zaniboni. Methods to Treat the Edentulous Posterior Maxilla: Implants with Sinus Grafting. J Oral Maxillofac Surg 67: 867-871, 2009.

7. ten Bruggenkate CM, Asikainen P, Foitzik C, et al: Short (6-mm) nonsubmerged dental implants: Results of a multicenter clinical trial of 1 to 7 years. Int J Oral Maxillofac Implants 13:791, 1998.

8. Romeo E, Ghisolfi M, Rozza R, et al: Short (8-mm) dental implants in the rehabilitation of partial and complete edentulism: A 3 to 14-year longitudinal study. Int J Prosthodont 19:586, 2006.

9. Renouard F, Nisand D: Short implants in the severely resorbed maxilla: A 2-year retrospective clinical study. Clin. Implant Dent Relat Res 7:104, 2005 (suppl 1).

10. Anitua E, Orive G, Aguirre JJ, et al: Five-year clinical evaluation of short dental implants placed in posterior areas: A retrospective study. J Periodontol 79:42, 2008.

11. Krekmanov L, Kahn M, Rangert B, et al: Tilting of posterior mandibular and maxillary implants for improved prosthesis support. Int J Oral Maxillofac Implant 15:405, 2000.

12. Aparicio C, Perales P, Rangert B: Tilted implants as an alternative to maxillary sinus grafting: A clinical, radiologic, and periotest study. Clin Implant Dent Rel Res 3:39, 2001.

13. Hirsch J, Ohrnell LO, Henry P, et al: A clinical evaluation of the zygoma fixture: One year of follow-up at 16 clinics. J Oral Maxillofac Surg 62:22, 2004.

14. Kahnberg KE, Henry PJ, Hirsch JM, et al: Clinical evaluation of the zygoma implant: Three-year follow-up at 16 clinics. J Oral Maxillofac Surg 65: 20-33, 2007.

15. Arun K. Garg, Current Concepts in Augmentation Grafting of the Maxillary Sinus for Placement of Dental Implants Dental Implantology Update™ March 2001.

16. Chiapasco M, Zaniboni M, Rimondini L: Dental implants placed in grafted maxillary sinuses: A retrospective analysis of clinical outcome according to the initial clinical situtation and a proposal of defect classification. Clin Oral Implant Res 19:416, 2008.

17. Coatoam G.W., Krieger J.T. A four year study examining the results of indirect sinus augmentation procedures. J. Oral Implant. 1997; 23: 117-27.

18. Boyne PJ, James RA. Grafting of the maxillary sinus floor with autologous marrow and bone. J Oral Surg 1980; 38: 613-16.

19. Cawood J.I., Howell R.A. A Classification of the Edentulous Jaws. Int. J. Oral Maxillofac. Surg. 1988: 17: 232-6.

20. Nkenke E., Kloss F., Wiltfang J., Schultze-Mosgau S. Radespiel-Troger M., Loos K., Neukam F.W. Histomorphometric and fluorescence microscopic analysis of bone remodelling after installation of implants using an osteotome technique. Clin. Oral Implants Res. 2002a; 13: 595-602.

21. Johan P. A. van den Bergh, Christiaan M. ten Bruggenkate, Frans J. M. Disch, D. Bram Tuinzing; Anatomical aspects of sinus floor elevations; Clin. Oral Impl. Res. 2000: II: 256-265.

22. Uchida Y., Goto M., Katsuki T., Soejima Y. Measurement of maxillary sinus volume using computerized tomographic scan analysis. Int. J. Oral Maxillofac. Implants 1998; 13:811-8.